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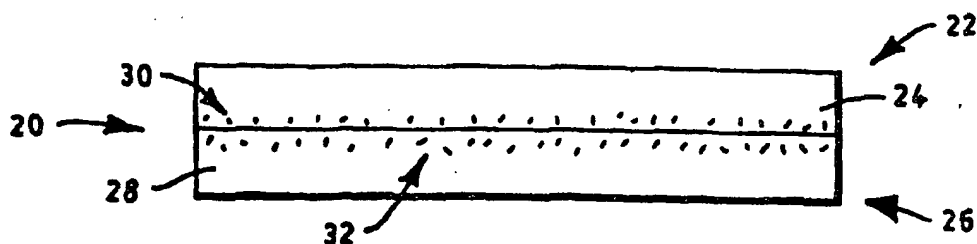
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## (57) Abstract

A toilet tissue product (20) may include a first cellulosic ply (22) and a second cellulosic ply (26). Desirably, the first cellulosic ply further includes a single layer (24) and the second cellulosic ply further includes a single layer (28). At least one ply may have a region (30) that prevents fluid from striking through the tissue product.

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**TISSUE WITH STRIKETHROUGH RESISTANCE****CROSS REFERENCE TO RELATED APPLICATIONS**

- 5        This application is a continuation-in-part of U.S. patent application serial number 08/638,522, filed April 26, 1996.

**FIELD OF THE INVENTION**

- 10       This invention generally relates to the field of paper making, and more specifically, to a tissue with strikethrough resistance.

**BACKGROUND**

- 15       During cleaning after urination the amount of tissue used may be highly variable, but generally about 12 to 15 tissue sheets are used per event for absorbing about 1 milliliter of urine. This tissue amount is about 14 times the actual amount needed based upon tissue's absorption capacity. Using this excessive tissue amount prevents urine  
20       from striking through the tissue sheet and reaching the user's hand. Unfortunately, this practice results in tissue waste, which expends economic and degrades environmental resources.

- 25       Accordingly, a tissue product that has strikethrough resistance may reduce tissue sheet use by allowing the utilization of the entire absorbency capacity of the tissue, thereby reducing tissue consumption rates and waste.

**30       DEFINITIONS**

As used herein, the term "repellant agent" refers to an agent that resists absorption of a liquid, desirably an aqueous liquid. The repellant agent may repel liquids by filling interstitial voids in the fibrous structure of a

tissue or coating individual fibers preventing liquids from being absorbed by and passing through the fibers to the interior of the fibrous structure. The repellant agent may be hydrophobic and may include such materials as sizing agents, waxes, and latexes. Furthermore, the repellant agent may be any hydrophobic chemical, such as the agent sold under the trade name REACTOPAQUE by Sequa Chemicals, Inc. at One Sequa Dr., Chester, South Carolina 29706. The amount of repellant agent added to the fibers may be from about 1 to about 30 pounds per ton of fiber, more specifically from about 1.2 to about 20 pounds per ton of fiber, and still more specifically, from about 2 to about 10 pounds per ton of fiber.

As used herein, the term "latex" refers to a colloidal water dispersion of high polymers from sources related to natural rubber, such as Hevea tree sap, or of synthetic high polymers that resemble natural rubber. Synthetic latexes may be made by emulsion polymerization techniques from styrene-butadiene copolymer, acrylate resins, polyvinyl acetate, and similar materials.

As used herein, the term "layer" refers to a single thickness, course, stratum, or fold that may lay or lie over or under another. An example of a several layered structure is depicted in FIG. 3, where a toilet tissue product includes three layers 84, 86, and 88.

As used herein, the term "ply" refers to a material produced from a headbox having one or more layers. An exemplary toilet tissue product having two-ply structure is depicted in FIG. 1, where a product 10 includes two plies 22 and 26.

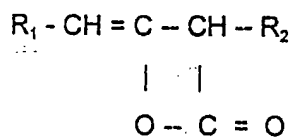
As used herein, the term "wax" refers to aqueous emulsions of small particles held in suspension by emulsifying agents and may include materials such as paraffin waxes, microcrystalline wax, or other waxes.

As used herein, the term "sizing agent" refers to any chemical inhibiting liquid penetration to cellulosic fiber structures. Suitable sizing agents are disclosed in a text entitled "Papermaking and Paper Board Making," second  
5 edition, Volume III, edited by R. G. MacDonald, and J. N. Franklin, which is herein incorporated by reference.

Sizing agents are commonly added to control the penetration of aqueous liquids into paper or other fibrous structures. In many cases, a certain resistance is required  
10 for end use. When surface treatments are applied with conventional equipment, such as sprayers or applicators, often sizing is required in the base sheet to control pickup of the aqueous solution. Paper grades such as butcher's wrap, milk carton, linerboard, bleached and unbleached bag,  
15 fine paper, cylinder board, and corrugated medium are routinely sized.

Internal sizing agents, which are those applied to the fibers within the paper structure, provide a reduced rate of penetration by retarding the rate of flow through the inter-  
20 fiber capillaries of the paper, as measured by test procedure ASTM D 779-94. When sizing is accomplished, the contact angle at the fiber surface is 90 degrees or greater, as measured by test procedure ASTM D 5725-95 or TAPPI Test Method T-458. Internal sizing agents function through the  
25 use of low surface energy, hydrophobic chemicals which when attached to the surface of cellulose reduce the surface energy of the fiber surface.

Particularly suitable sizing agents are acid or alkaline sizes such as acid rosin, alkenyl succinic anhydride, alkyl  
30 ketone dimers and alkenol ketene dimers of the formula:



wherein  $R_1$  and  $R_2$  are based on  $C_{16}$  -  $C_{18}$ , aliphatic carbon chains, which can be the same or different. Exemplary commercially available sizing agents of this type are HERCON 79, HERCON 1332, and PRECIS 3000 from Hercules, Inc.,

5 Wilmington, Delaware. The amount of the sizing agent added to the fibers may be from about 0.5 to about 10 pounds per ton of fiber, more specifically from about 1.0 to about 3 pounds per ton of fiber, and still more specifically, from about 2 to about 2.5 pounds per ton of fiber.

10 As used herein, the term "strike-through prevention region" refers to an area in a tissue product treated with a repellent agent. The strike-through prevention region impedes or stops the penetration of liquid from one side of the tissue product to the other.

15 As used herein, the term "cellulosic material" refers to material that may be prepared from cellulose fibers from synthetic source or natural sources, such as woody and non-woody plants. Woody plants include, for example, deciduous and coniferous trees. Non-woody plants include, for example,  
20 cotton, flax, esparto grass, milkweed, straw, jute, hemp, and bagasse. The cellulose fibers may be modified by various treatments such as, for example, thermal, chemical and/or mechanical treatments. It is contemplated that reconstituted and/or synthetic cellulose fibers may be used and/or blended  
25 with other cellulose fibers of the fibrous cellulosic material. Desirably, no synthetic fibers are woven into the cellulosic material fibers.

As used herein, the term "pulp" refers to cellulosic fibrous material from sources such as woody and non-woody  
30 plants. Woody plants include, for example, deciduous and coniferous trees. Non-woody plants include, for example, cotton, flax, esparto grass, milkweed, straw, jute, hemp, and bagasse. Pulp may be modified by various treatments such as, for example, thermal, chemical and/or mechanical treatments.

Desirably, no synthetic fibers are woven into the pulp fibers.

As used herein, the term "bleached-chemical-thermo-mechanical pulp" refers to processing cellulosic material with steam, pressure and sodium sulfite or hydrogen peroxide to soften wood lignin between and within cell walls. Furthermore, alkaline peroxide bleaching is added to further soften and brighten the fibers. The term bleached-chemical-thermo-mechanical pulp may be hereinafter abbreviated as "BCTMP" and may be more hydrophobic than Kraft fiber.

As used herein, the term "sulfite pulp" refers to pulp processed chemically with a mixture of sulfurous acid and bisulfite ion. These chemicals attack and solubilize the lignin in the pulp feedstock. Sulfite pulp may be more hydrophobic than Kraft fiber.

As used herein, the term "basis weight" (hereinafter may be referred to as "BW") is the weight per unit area of a sample and may be reported as gram-force per meter squared. The basis weight may be measured using test procedure ASTM D 3776-96 or TAPPI Test Method T-220.

#### SUMMARY OF THE INVENTION

The problems and needs described above are addressed by the present invention, which provides a toilet tissue product that may include a first cellulosic ply and a second cellulosic ply. Each ply may further include a single layer. At least one ply may have a region that prevents fluid from striking through the tissue product. Furthermore, at least one ply may be treated with a repellant agent to create a region for preventing fluid strikethrough. Moreover, at least one ply may be printed and/or sprayed with a repellant agent. In addition, the repellant agent may be a sizing agent or hydrophobic chemical.

Another embodiment of a toilet tissue product may include a first cellulosic ply further having a first layer

and a second layer and a second cellulosic ply further having a first layer and a second layer. The first layers of the plies may substantially sandwich the second layers of the plies, where at least one of the second layers may be  
5 resistant to fluid strikethrough. In addition, at least one of the second layers may include a repellant agent. Moreover, the repellant agent may be a wax, latex, hydrophobic chemical and/or sizing agent. Furthermore, the repellant agent may be printed onto at least one of the  
10 second layers. Additionally, the repellant agent may be sprayed onto at least one of the second layers. Also, the repellant agent may be mixed in with the fibers of at least one of the second layers in a headbox. Further, at least one of the second layers may include sulfite pulp or BCTMP.

15 Another embodiment of the present invention is a toilet tissue product not treated with a permanent wet strength binder, which may include a first cellulosic ply further including first, second, and third layers. The first and third layers may sandwich the second layer, which may be  
20 resistant to fluid strikethrough. In addition, the second layer may further include a repellant agent. Moreover, the repellant agent may be wax, latex, and/or a sizing agent. Furthermore, the repellant agent may be printed onto the second layer. Additionally, the repellant agent may be  
25 sprayed onto the second layer. Also, the repellant agent may be mixed in with the fibers of the second layer in a headbox. Further, the second layer may include sulfite pulp or BCTMP.

A further embodiment of the present invention is a toilet tissue product not treated with a permanent wet  
30 strength binder, which may include a first, second, and third cellulosic plies. The first and third plies may sandwich the second ply, which may be resistant to fluid strikethrough. In addition, the second ply may further include a repellant agent. Moreover, the repellant agent may be wax, latex,  
35 and/or a sizing agent. Furthermore, the repellant agent may



be printed onto the second ply. Additionally, the repellent agent may be sprayed onto the second ply. Also, the repellent agent may be mixed in with the fibers of the second ply in a headbox. Further, the second ply may include sulfite pulp or  
5 BCTMP.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a magnified, but not necessarily to scale, side elevational view of one embodiment of a toilet tissue product having a fluid strikethrough barrier.  
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FIG. 2 is a magnified, but not necessarily to scale, side elevational view of another embodiment of a toilet tissue product having a fluid strikethrough barrier.

FIG. 3 is a magnified, but not necessarily to scale, side elevational view of still another embodiment of a toilet tissue product having a fluid strikethrough barrier.  
15

FIG. 4 is an illustration of an exemplary process for making a toilet tissue product.

FIG. 5 is an illustration of another exemplary process for making a toilet tissue product.  
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FIG. 6 is an illustration of still another exemplary process for making a toilet tissue product.

FIG. 7 graphically compares subjects' perception of fluid strikethrough for a control tissue roll and three tissue rolls of the present invention.  
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#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring now to the drawings, wherein like reference numerals designate corresponding structure throughout the views, and referring in particular to FIGS. 1-3, there are three embodiments of toilet tissue products 20, 50, and 80. The toilet tissue product 20 may include a first cellulosic ply 22 and a second cellulosic ply 26. The basis weight of the tissue product 20 may vary from about 8 gram-force per square meter (hereinafter may be abbreviated as "gsm") to  
35

about 59 gsm, desirably from about 17 gsm to about 34 gsm, and more desirably about 27 gsm. Each ply 22 and 26 may have a basis weight of about 4 gsm.

Desirably, each ply 22 and 26 includes, respectively, a single layer 24 and 28. The layer 24 may be treated with a repellent agent to form a first fluid strikethrough prevention region or barrier 30. Optionally, the layer 28 may be treated with a repellent agent to form a second fluid strikethrough prevention region or barrier 32. Desirably, a sizing agent is sprayed or applied to the layers 28 and 30 for creating, respectively, regions 30 and 32. Although the fluid strikethrough regions are shown in the interior of the tissue product 20, it should be understood that one or more strikethrough regions may be instead located on the exterior of the tissue product 20. Furthermore, a ply 22 or 26 may be formed with a repellent agent creating a strikethrough region as hereinafter described. The plies 22 and 26 may be formed from pulp fibers using any suitable papermaking techniques, and one such exemplary technique will be hereinafter described. The plies 22 and 26 may be bonded together using any suitable means, such as adhesives or pressure applied by a knurling or ply-bonding wheel. Exemplary bonding techniques are disclosed in U.S. Patent Nos. 5,698,291, 5,622,734, and 5,543,202, which are hereby incorporated by reference. If a knurling wheel is utilized, desirably, only the edges of the plies 22 and 26 are bonded together.

The toilet tissue product 50 may include a first cellulosic ply 52 and a second cellulosic ply 58. The basis weight of the tissue product 50 may vary from about 8 gsm to about 59 gsm, desirably from about 17 gsm to about 34 gsm, and more desirably from about 27 gsm. Each ply 54 and 60 may have a basis weight of about 4 gsm.

Desirably, the ply 52 includes a first layer 54 and a second layer 56, and the ply 58 includes a first layer 60 and

a second layer 62. The layer 56 may be treated with a repellent agent to prevent fluid strikethrough. The repellent agent, such as a sizing agent, may be sprayed or printed onto the layer 56, or alternatively, the repellent agent, such as a wax, latex, or hydrophobic chemical may be incorporated into the layer 56 during the papermaking process. Optionally, the layer 62 may be treated with a repellent agent to prevent fluid strikethrough. The repellent agent, such as a sizing agent, may be sprayed or printed onto the layer 62, or alternatively, the repellent agent, such as a wax or latex, may be incorporated into the layer 62 during the papermaking process. Additionally, a plurality of repellent agents may be used, which may be sprayed and/or incorporated into the layers 56 and/or 62.

The layers 54, 56, 60, and 62 may be formed using any suitable papermaking techniques, and one such exemplary technique will be hereinafter described. Desirably, the layers 54 and 56 are processed through a headbox to form the ply 52 and the layers 60 and 62 are processed through a headbox to form the ply 58. The plies 52 and 58 may be bonded together using any suitable means, such as adhesives or pressure applied by a knurling wheel. Exemplary bonding techniques are disclosed in U.S. Patent Nos. 5,698,291, 5,622,734, and 5,543,202, which are hereby incorporated by reference. If a knurling wheel is utilized, desirably only the edges of the plies 52 and 58 are bonded together.

The toilet tissue product 80 may include a first cellulosic ply 82. The basis weight of the tissue product 80 may vary from about 8 gsm to about 59 gsm, desirably from about 17 gsm to about 34 gsm, and more desirably about 27 gsm. Desirably, the ply 82 includes a first layer 84, a second layer 86, and a third layer 88. The layer 86 may be treated with a repellent agent to prevent fluid strikethrough. The repellent agent, such as a sizing agent, may be sprayed onto the layer 86, or alternatively, the

repellant agent, such as a wax, latex, or hydrophobic chemical may be incorporated into the layer 86 during the papermaking process. Additionally, a plurality of repellant agents may be used, which may be sprayed and/or incorporated into the layer 86.

The layers 84, 86 and 88 may be formed using any suitable papermaking techniques, and one such exemplary technique will be hereinafter described. The layers 84, 86, and 88 may be processed through a headbox to form the ply 82. Alternatively, the toilet tissue product 80 may be formed from three single-layer plies corresponding to layers 84, 86, 88. The plies may be bonded together as previously described to form a three ply product 80 having a total of three layers.

Tissue products 20, 50, and 80 have regions providing strikethrough resistance that impede or slow the absorbency of fluid through the tissue. It should be understood that some pulps, such as sulfite pulp or BCTMP, have strikethrough resistance properties. Thus, these pulps may be used as a substitute to a repellant agent or as an aid for slowing absorbency. Furthermore, the toilet tissues 20, 50, and 80 of the present invention, unlike conventional facial tissues, may not contain permanent wet strength binder materials. Wet strength binder materials may include polyamide-epichlorohydrin, polyacrylamides, styrenebutadiene latexes, insolubilized polyvinyl alcohol, urea-formaldehyde, polyethyleneimine, chitosan polymers, and mixtures thereof. Generally, it is undesirable to add permanent wet strength binder materials to toilet tissue because these materials impede the dissolution of the tissue in a toilet bowl.

FIGS. 4-6 depict exemplary processes for forming, respectively, tissue products 20, 50, and 80. Although the hereinafter paper forming lines utilize creping, an uncreped paper forming line, such as those disclosed in U.S. Patent

Nos. 5,048,589 and 5,399,421, which are hereby incorporated by reference, may be used instead.

FIG. 4 depicts an exemplary process for forming the toilet tissue product 20, which may include a wet stock line 102 and a paper forming line 156. The wet stock line 102 may include a chest 104, a stuffbox 108, and a fan pump 116.

Desirably, the chest 104 stores an aqueous suspension of papermaking fibers, such as sulfite pulp or BCTMP, which is fed via a stream 106 to the stuffbox 108 for maintaining a constant pressure head. An outlet stream 112 of the stuffbox 108 may be sent to the fan pump 116. A discharge 118 from the fan pump 116 may be then sent to the paper forming line 156.

The paper forming line 156 may include a headbox 120, a forming fabric 124, a form roll 126, a press felt 128, a vacuum pressure roll 130, a Yankee dryer 136, an air hood 140, a doctor blade 144, and a core 152. Desirably, the headbox 120 receives the discharge 118 from the fan pump 116 and continuously injects or deposits the aqueous paper fiber suspension between the forming fabric 124 and the press felt 128, which is partially wrapped around the form roll 126. Water may be removed from the suspension through the forming fabric 124 by centrifugal force as the newly formed web traverses the arc of the form roll 126. Desirably, the wet web is dewatered to a consistency of about 12 dry weight percent prior to the vacuum pressure roll 130.

After the forming fabric 124 and the press felt 128 separate, the wet web may be transported on the press felt 128 to the vacuum pressure roll 130 where it may be pressed against the Yankee dryer 136 for drying.

An aqueous adhesive mixture may be sprayed evenly and continuously via a spray boom 132 onto the dryer surface of the Yankee dryer 136. The point of application onto the dryer surface may be between the blade 144 and the vacuum pressure roll 130. The adhesive mixture may aid in the

adhesion of the web to the Yankee dryer 136, and thereby may enhance the crepe performance when removing the sheet from the dryer 136 via the blade 144. The creped tissue may be wound onto the core 152 in the reel section, which runs at a speed about 30% slower than the dryer 136. A repellent agent, such as a sizing agent, may be applied to the dry web by spraying an aqueous solution through the spray boom 148 located between the blade 144 and the core 152. Alternatively, the repellent agent may be sprayed or coated onto the moving tissue web prior to the pressure roll 130 or after the tissue web has transferred to the Yankee dryer 136.

Figure 5 depicts an exemplary process 200 for forming a single ply of the toilet tissue product 50, such as the ply 52. The process 200 may include wet stock lines 210 and 230, and a paper forming line 256.

The wet stock line 210 may include a chest 214, a stuffbox 218, and a fan pump 216. The chest 214 may store an aqueous suspension of papermaking fibers, such as sulfite pulp or BCTMP, which may be fed via a stream 216 to the stuffbox 218 for maintaining a constant pressure head. An outlet stream 222 of the stuffbox 218 may be sent to the fan pump 226. A discharge 228 from the fan pump 226 may be then sent to the paper forming line 256.

The wet stock line 230 may include a chest 234, a stuffbox 238, and a fan pump 246. The chest 214 may store an aqueous suspension of papermaking fibers, which may be fed via a stream 236 to the stuffbox 238 for maintaining a constant pressure head. An amount of repellent agent 240, such as a wax, latex, hydrophobic chemical, and/or sizing agent, may be added to the stuffbox 238 for forming a pulp layer having fluid strikethrough prevention properties. An outlet stream 242 of the stuffbox 238 may be sent to the fan pump 246. A discharge 248 from the fan pump 246 may be then sent to the paper forming line 256.

Desirably, the paper forming line 256 includes a layered headbox 260, a forming fabric 264, a form roll 266, a press felt 268, a vacuum pressure roll 270, a Yankee dryer 276, an air hood 280, a doctor blade 284, and a core 288. The  
5 headbox 120 may receive the discharges 228 and 248 from the fan pumps 226 and 246, and may continuously inject or deposit the aqueous paper fiber suspensions between the forming fabric 264 and the press felt 268, which may be partially wrapped around the form roll 266. This deposition may form a  
10 two-layered slurry on the forming fabric 264. Water may be removed from the suspension through the forming fabric 264 by centrifugal force as the newly formed web traverses the arc of the form roll 266. The wet web may be dewatered to a consistency of about 12 dry weight percent prior to the  
15 vacuum pressure roll 270.

After the forming fabric 264 and the press felt 268 separate, the wet web may be transported on the press felt 268 to the vacuum pressure roll 270 where it may be pressed against the Yankee dryer 276 for drying. Generally, high  
20 temperatures may aid in the curing of the repellant agent.

Desirably, an aqueous adhesive mixture is sprayed evenly and continuously via a spray boom 272 onto the dryer surface of the Yankee dryer 276. The point of application onto the dryer surface may be between the blade 284 and the vacuum  
25 pressure roll 270. The adhesive mixture may aid in the adhesion of the web to the Yankee dryer 276, and thereby may enhance the crepe performance when removing the sheet from the dryer 276 via the blade 284. Desirably, the creped tissue is wound onto the core 288 in the reel section which  
30 runs at a speed about 30% slower than the dryer 276. The wound tissue may be in the form of a single ply having two layers, such as the ply 52.

Optionally, a repellant agent, such as a sizing agent, may be sprayed or coated between the blade 284 and the core  
35 288, onto the moving tissue web prior to the pressure roll

270, and/or after the tissue web has transferred to the Yankee dryer 276.

5 A second ply, such as ply 58, may be made in a similar fashion as depicted in FIG. 5. The tissue product 50 may be created by ply bonding plies 52 and 58, using any suitable means such as adhesives or pressure, with the ply 58 being orientated in a mirror relation with the ply 52, thereby sandwiching second layers 56 and 62 with the first layers 54 and 60 and forming a palindromic structure.

10 Figure 6 depicts an exemplary process 300 for forming a single ply of the toilet tissue product 80, such as the ply 82. The process 300 may include wet stock lines 310, 330, and 350, and a paper forming line 306.

15 The wet stock line 310 may include a chest 314, a stuffbox 318, and a fan pump 328. Desirably, the chest 314 stores an aqueous suspension of papermaking fibers, which is fed via a stream 316 to the stuffbox 318 for maintaining a constant pressure head. An outlet stream 322 of the stuffbox 318 may be sent to the fan pump 326. A discharge 328 from the fan pump 326 may be then sent to the paper forming line 306.

25 The wet stock line 330 may include a chest 334, a stuffbox 338, and a fan pump 346. Desirably, the chest 314 stores an aqueous suspension of papermaking fibers, such as sulfite pulp or BCTMP, which is fed via a stream 336 to the stuffbox 338 for maintaining a constant pressure head. An amount of repellant agent 340, such as a wax, latex, hydrophobic chemical, and/or sizing agent, may be added to the stuffbox 338 for forming a pulp layer having fluid strikethrough prevention properties. An outlet stream 342 of the stuffbox 338 may be sent to the fan pump 346. Desirably, a discharge 348 from the fan pump 346 is then sent to the paper forming line 306.

30 The wet stock line 350 may include a chest 354, a stuffbox 358, and a fan pump 368. The chest 354 may store an



aqueous suspension of papermaking fibers, which is fed via a stream 356 to the stuffbox 358 for maintaining a constant pressure head. An outlet stream 362 of the stuffbox 358 may be sent to the fan pump 366. A discharge 368 from the fan pump 366 may be then sent to the paper forming line 306.

The paper forming line 306 may include a layered headbox 370, a forming fabric 374, a form roll 376, a press felt 378, a vacuum pressure roll 380, a Yankee dryer 386, an air hood 390, a doctor blade 394, and a core 398. Desirably, the headbox 370 receives the discharges 328, 348, and 368 from the fan pumps 326, 346, and 366, and continuously injects or deposits the aqueous paper fiber suspensions between the forming fabric 374 and the press felt 378, which is partially wrapped around the form roll 376. This deposition may form a three-layered slurry on the forming fabric 374. Water may be removed from the suspension through the forming fabric 374 by centrifugal force as the newly formed web traverses the arc of the form roll 376. Desirably, the wet web is dewatered to a consistency of about 12 dry weight percent prior to the vacuum pressure roll 380.

After the forming fabric 376 and the press felt 378 separate, desirably, the wet web is transported on the press felt 378 to the vacuum pressure roll 380 where it is pressed against the Yankee dryer 386 for drying. Generally, high temperatures aid in the curing of the repellant agent.

An aqueous adhesive mixture may be sprayed evenly and continuously via a spray boom 382 onto the dryer surface of the Yankee dryer 386. The point of application onto the dryer surface may be between the blade 294 and the vacuum pressure roll 380. Desirably, the adhesive mixture aids in the adhesion of the web to the Yankee dryer 386, and thereby enhances the crepe performance when removing the sheet from the dryer 386 via the blade 394. The creped tissue may be wound onto the core 398 in the reel section, which may run at a speed about 30% slower than the dryer 386. The wound

tissue may be in the form of a single ply having three layers, such as the ply 82.

#### TESTING

5       A test measuring resistance to strikethrough was conducted by comparing a control tissue roll to three rolls produced by the present invention. Female subjects were asked to compare the strikethrough resistance of the four rolls after urination.

10       All rolls were formed from a refined recycled fiber furnish. Each roll contained two plies. Each ply had a basis weight of about 14 grams per square meter (gsm). The rolls of the present invention were treated with 0.12 weight percent per ply of a sizing agent, namely HERCON 79.

15       The first roll was the control. The second roll was printed or coated with the sizing agent. The third roll was sprayed with the sizing agent after the forming box and prior to web transfer. The fourth roll was formed with sizing agent metered into the top layer. Each ply had a top layer  
20 with sizing and a basis weight of about 5 gsm and a lower layer without sizing and a basis weight of about 8 gsm.

      The testing procedure involved fifty-three subjects. Each subject randomly evaluated each tissue product. Subjects were instructed to pull four complete bath tissue  
25 sheets off a tested roll and use the tissue according to their normal practice. Afterwards, the subjects evaluated the ability of fluid to strikethrough the tissue sheet. Results are depicted in FIG. 7.

      As depicted, rolls 2, 3, and 4 of the present invention  
30 were more likely to be perceived as having no strikethrough than the control roll, roll 1. Over fifty percent of the subjects perceived no fluid strikethrough for rolls 2, 3, and 4, while only about 30 percent of the subjects perceived no strikethrough for roll 1. As a result, the rolls of the

present invention were perceived as more likely to prevent fluid strikethrough than the control roll.

While the present invention has been described in connection with certain preferred embodiments, it is to be understood that the subject matter encompassed by way of the present invention is not to be limited to those specific embodiments. On the contrary, it is intended for the subject matter of the invention to include all alternatives, modifications and equivalents as can be included within the spirit and scope of the following claims.

## WHAT IS CLAIMED IS:

1. A toilet tissue product, comprising:  
a first cellulosic ply further comprising a single  
5 layer;  
a second cellulosic ply further comprising a single  
layer; and  
at least one ply having a region that prevents fluid  
from striking through the tissue product.  
10
2. The toilet tissue product of claim 1 wherein at least  
one ply is treated with a repellant agent to create a region  
for preventing fluid strikethrough.
- 15 3. The toilet tissue product of claim 2 wherein at least  
one ply is printed with a repellant agent.
4. The toilet tissue product of claim 2 wherein at least  
one ply is sprayed with a repellant agent.  
20
5. The toilet tissue product of claim 2 wherein the  
repellant agent is a sizing agent.
6. The toilet tissue product of claim 2 wherein the  
25 repellant agent is a hydrophobic chemical.
7. A toilet tissue product, comprising:  
a first cellulosic ply further comprising a first layer  
and a second layer; and  
30 a second cellulosic ply further comprising a first layer  
and a second layer wherein the first layers of the plies  
substantially sandwich the second layers of the plies, where  
at least one of the second layers is resistant to fluid  
strikethrough.  
35

8. The toilet tissue product of claim 7 wherein at least one of the second layers comprise a repellant agent.
9. The toilet tissue product of claim 8 wherein the  
5 repellant agent is wax.
10. The toilet tissue product of claim 8 wherein the repellant agent is latex.
- 10 11. The toilet tissue product of claim 8 wherein the repellant agent is a sizing agent.
12. The toilet tissue product of claim 8 wherein the repellant agent is a hydrophobic chemical.  
15
13. The toilet tissue product of claim 8 wherein the repellant agent is printed onto at least one of the second layers.
- 20 14. The toilet tissue product of claim 8 wherein the repellant agent is sprayed onto at least one of the second layers.
15. The toilet tissue product of claim 8 wherein the  
25 repellant agent is mixed with the fibers of at least one of the second layers in a headbox.
16. The toilet tissue product of claim 7 wherein at least one of the second layers comprise sulfite pulp.  
30
17. The toilet tissue product of claim 7 wherein at least one of the second layers comprise bleached-chemical-thermo-mechanical pulp.

18. A toilet tissue product not treated with a permanent wet strength binder, comprising:

5 a first cellulosic ply further comprising first, second, and third layers wherein the first and third layers sandwich the second layer which is resistant to fluid strikethrough.

19. The toilet tissue product of claim 18 wherein the second layer comprises a repellant agent.

10 20. The toilet tissue product of claim 19 wherein the repellant agent is wax.

21. The toilet tissue product of claim 19 wherein the repellant agent is latex.

15

22. The toilet tissue product of claim 19 wherein the repellant agent is a sizing agent.

20 23. The toilet tissue product of claim 19 wherein the repellant agent is printed onto the second layer.

24. The toilet tissue product of claim 19 wherein the repellant agent is sprayed onto the second layer.

25 25. The toilet tissue product of claim 19 wherein the repellant agent is mixed in with the short fibers of the second layer in a headbox.

30 26. The toilet tissue product of claim 18 wherein the second layer comprises sulfite pulp.

27. The toilet tissue product of claim 18 wherein the second layer comprises bleached-chemical-thermo-mechanical pulp.

28. A toilet tissue product not treated with a permanent wet strength binder, comprising:

a first cellulosic ply;

a second cellulosic ply; and

5 a third cellulosic ply wherein the first and third plies sandwich the second ply which is resistant to fluid strikethrough.

29. The toilet tissue product of claim 28 wherein the second  
10 ply comprises a repellant agent.

30. The toilet tissue product of claim 29 wherein the repellant agent is wax.

15 31. The toilet tissue product of claim 29 wherein the repellant agent is latex.

32. The toilet tissue product of claim 29 wherein the repellant agent is a sizing agent.

20

33. The toilet tissue product of claim 29 wherein the repellant agent is printed onto the second ply.

34. The toilet tissue product of claim 29 wherein the  
25 repellant agent is sprayed onto the second ply.

35. The toilet tissue product of claim 29 wherein the repellant agent is mixed in with the short fibers of the second ply in a headbox.

30

36. The toilet tissue product of claim 28 wherein the second ply comprises sulfite pulp.

37. The toilet tissue product of claim 28 wherein the second  
35 ply comprises bleached-chemical-thermo-mechanical pulp.

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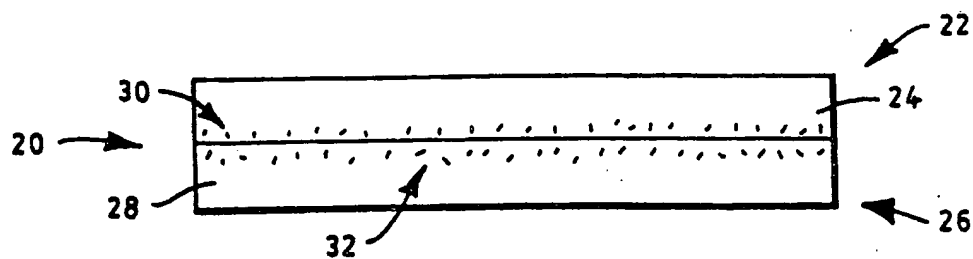


FIG. 1

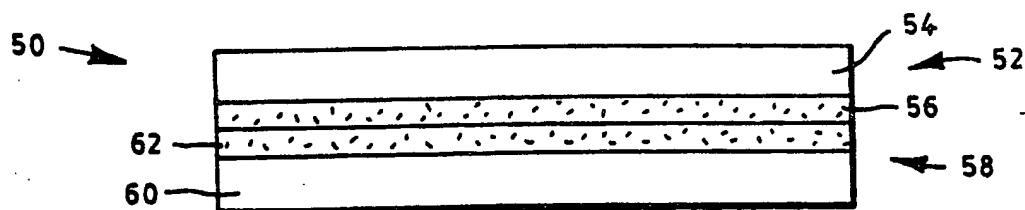


FIG. 2

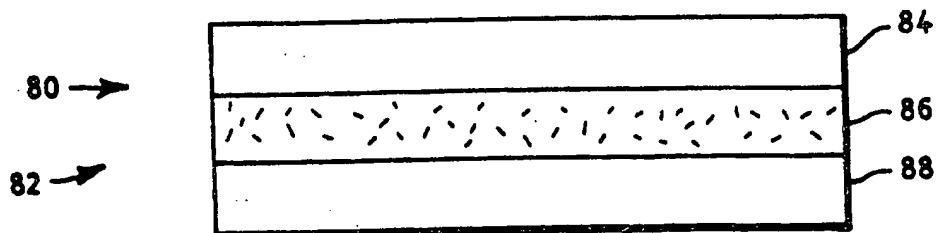


FIG. 3



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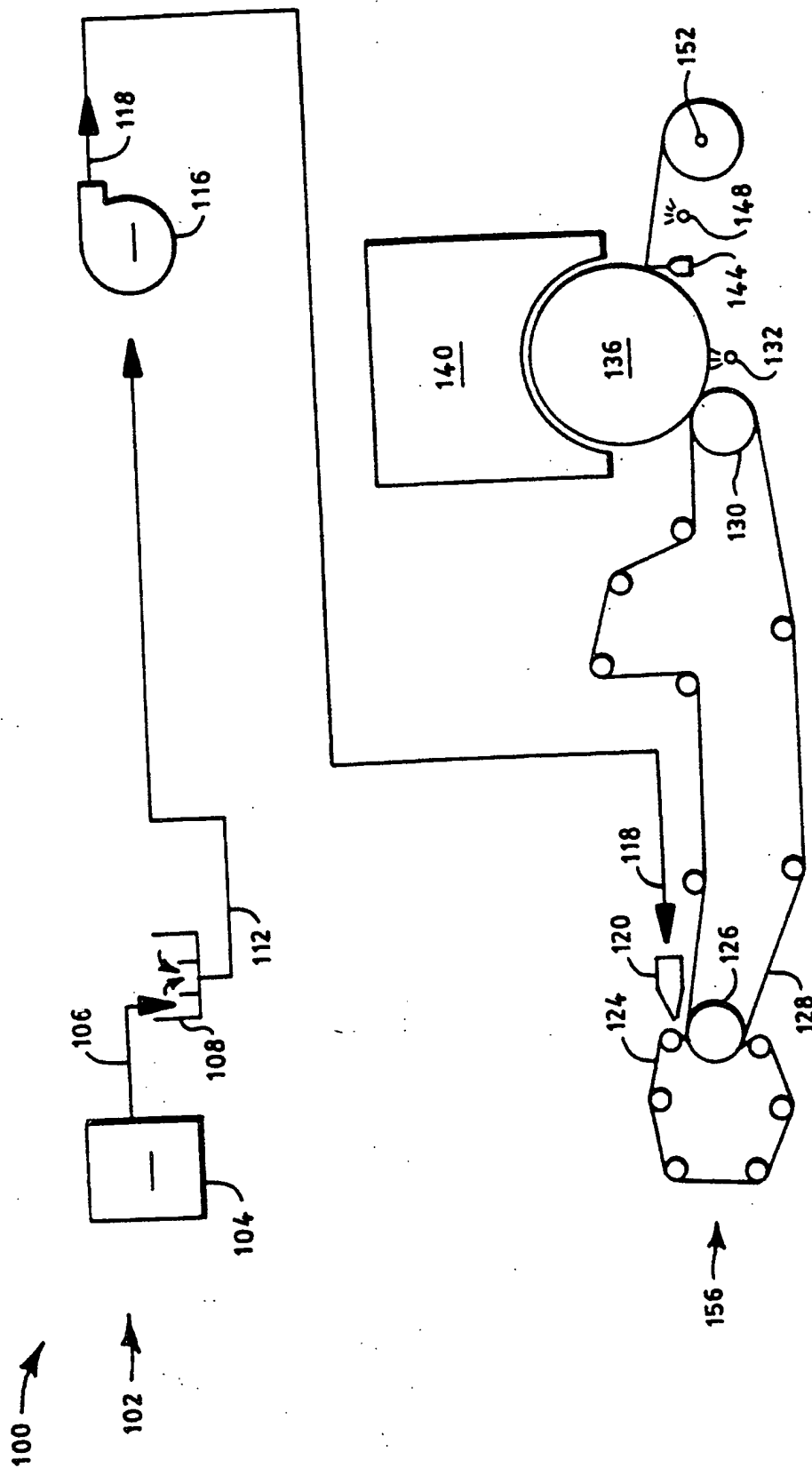


FIG. 4

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Information on patent family members

International Application No

PCT/US 99/14402

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